due to cyclones at a distance which were not coming our way that we can not claim to have seriously dealt with more than twenty or so. At any rate no mistake has yet been made; the hurricane signals have been ordered up only thrice, August 18, 1880, August 20, 1886, and September 15, 1889.

Forecasts for daily rainfall were fairly successful, but could not reach those interested.

Forecasts for monthly rainfall were commenced in 1884 and discontinued in 1886; of these 80 per cent were correct, but the subject required more attention than I could give it, and when a large rainfall was forecast for May, 1886, which month proved unusually dry, and when with an average forecast for June, 1886, heavy rains fell June 5, and 6, and floods did great damage, it was clearly time to stop this mode of forecasting.

The following are the investigations which have been undertaken:

Barometer, diurnal variation of.—For every hour for each month of the year. (Weather report No. 192.)

Barometric pressures, mean (W. R. 192, and errata Vol. II).—Very special photographic arrangements were made by Mr. J. F. Brennan, who took and reduced the observations. With regard to the mean, it was found that the mean of the three readings at 7 a. m., 3 p. m., and 11 p. m. exactly agreed with the mean of the readings taken every hour.

Clouds, classification of (W. R. 193).—The classification is essentially the same as that adopted by the International Committee, but strato-cirrus was added; it is a cloud somewhat resembling cirro-stratus, but thick and woolly; it is a purely tropical cloud according to Mr. Abercomby.

Cyclones of 1880 (W. R. Vol. I, introduction).—An investigation of the two cyclones which passed over Jamaica August 18, that year, including their reciprocal movements.

Cyclones, generally, as observed in Jamaica (W. R. 96).

Cyclones, tropical (Nature, vol. 46, p. 393).—If a cyclone is approaching any place the time of arrival is the fall of the barometer below the mean divided by twice the rate of fall, and consequently it is possible to ascertain whether the cyclone is directly approaching or not, by the constancy in the time of arrival, as shown by observations made every two or four hours. This rule is most useful for isolated places.

Earthquakes (W. R. 77).—The cause of the oppressive weather before an earthquake is due to the stopping or diminution of the wind as shown by self-registering instruments. The barometer is also affected, and there is a tendency for stratus to form over the sky. There are not enough earthquakes in Jamaica to complete the investigation, but the recording instruments are kept constantly in perfect working order.

Health of Kingston (W. R. 123).—The connection between the meteorological results and the health of the chief town in Jamaica is interesting in many ways. In Jamaica the people suffer from *cold*, not from heat. There are nearly twice as many deaths in March after the cooler weather in January and February as there are in September after the hotter weather in July and August, and this is accentuated with respect to infantile mortality; for infants the ratio is *thrice* instead of twice.

Lightning, protection of buildings from (W. R. 136).—Confirming the report of the British Lightning Rod Conference, 1882.

Magnetic variation (W. R. 182).—Between the years 1700 and 1820 the variation of the compass was practically steady. Of late years it has been rapidly changing; the results of the investigation are given in a practical form.

Rainfall maps (published by the Jamaica Institute).—The colored maps are based upon observations made at about 153 stations for about twenty years, and they show the average distribution over the island for each month.

Rainfall and sun-spot period (Nature, vol. 49, p. 399).—The table given in Nature takes in Barbados, Antigua, and Trinidad, as well as Jamaica. It does not seem to be of much use for forecasting purposes. In 1893 I gave out that that year and the next few years would probably be drier than usual—the sun-spot maximum was then approaching, and 1891 had been unusually wet—but 1893 proved to be still wetter, and it was not until two or three years after the maximum in 1893 that drought was severely felt in certain parts of the Island, and the connection preserved.

Results, meteorological (W. R. 123).—These are for the most part means for ten years, 1880–89, with notes.

Temperature and pressure (Nature, vol. 35, p. 437, and vol. 36, p. 197).—The decrease of minimum temperature as we ascend in the air follows a law which is useful in many ways, and if we define the temperature of space to be that shown by a thermometer at a great distance from the earth and shaded by the earth from the sun, we find its temperature to be −311° F.

Tides in Kingston Harbor (W. R. 227).—When the moon's declination is small there are two very small tides in the twenty-four hours; when the moon's declination exceeds 9° north or south there is only one small tide in the twenty-four hours. This investigation is referred to here in consequence of the discovery of the variation of mean sea level with monthly temperature of the air. Let T be half the sum of the mean temperature of the air for any month and for the preceding month, then the

$$\text{Mean sea level} = \text{constant} + 0.84 \text{ inch} \times (T - 78.6°).$$

This seems to show that the variations of T are carried down as much as 500 feet below the ocean level.

Winds in Kingston (W. R. 200).—A careful investigation of the sea and land breezes by Mr. Brennan, as felt in Kingston.

The monthly form accompanying this article shows that the Jamaica Weather Service calls for the following data from its stations:

Latitude, longitude, height of barometer above mean sea level, height of rain gauge above mean sea level and above ground.

Barometric pressure at 7 a. m. and 3 p. m., reduced to standard temperature, the Kew standard barometer, standard gravity, mean sea level.

The air temperature (7 a. m., 3 p. m., max., min.) by corrected thermometers exposed on a lawn in a Stevenson screen.

The dew-point and relative humidity, 7 a. m. and 3 p. m. from the readings of the dry and wet bulb thermometers by Glaisher's Tables.

The rainfall at 7 a. m. daily, for the preceding twenty-four hours, as given by a rain gauge 8 inches in diameter.

The total daily movement of the wind at 7 a. m., as given by a small Robinson anemometer, in which the factor 3 is used.

The direction and velocity of the wind at 7 a. m. and 3 p. m., using the true meridian, and, if necessary, the estimated wind velocity, according to the Signal Service scale (light 1 to 2 miles per hour; gentle, 3 to 5; fresh, 6 to 14; brisk, 15 to 24; high, 25 to 39; gale, 40 to 59; storm, 60 to 79; hurricane, 80 and over).

Clouds, kind, amount, and direction of motion at 7 a. m. and 3 p. m., classified as lower, viz, fracto-stratus; middle, viz, cumulus; upper, viz, cirrus and cirro-stratus.

RAINFALL AT RIVAS, NICARAGUA.

By Dr. EARL FLINT.

Dr. Earl Flint, voluntary observer at Rivas, Nicaragua, has kindly furnished the accompanying table of monthly and

annual precipitation at that place, from January, 1880, to April, 1897, both inclusive. The station is located at N. 11° 26′, W. 85° 47′; elevation, 210 feet.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1880...	0.00	0.00	0.00	0.00	10.23	12.58	3.62	10.48	7.95	13.83	5.02	0.67	64.38
1881...	0.00	0.00	0.00	0.12	5.20	13.17	8.88	6.96	7.42	24.67	10.88	1.91	79.21
1882...	0.00	0.13	0.00	0.00	4.26	9.80	4.04	6.25	7.65	23.38	4.20	1.61	61.32
1883...	0.28	0.00	0.00	0.14	1.00	8.07	4.87	4.34	5.78	18.25	5.70	1.34	49.77
1884...	0.59	0.09	0.00	2.03	2.80	10.43	4.98	3.84	4.48	15.83	7.43	2.24	54.74
1885...	0.04	0.00	0.00	0.00	1.78	7.27	4.81	2.76	5.40	7.88	4.36	0.29	34.59
1886...	0.23	0.30	0.00	0.17	13.00	7.87	15.00	20.80	15.30	10.40	3.75	0.49	87.21
1887...	0.90	0.81	0.00	0.00	9.17	8.18	4.10	5.03	19.42	22.47	2.50	2.31	74.89
1888...	1.83	0.04	0.00	0.00	7.12	8.50	4.18	5.00	9.80	16.80	1.11	1.13	55.51
1889...	0.00	0.19	0.07	1.71	11.34	11.64	7.48	12.95	9.80	24.13	3.38	1.67	84.36
1890...	0.49	0.11	0.94	0.00	2.63	4.56	4.73	3.78	2.77	9.68	1.30	0.82	31.81
1891...	0.00	0.00	0.00	0.78	0.75	24.58	4.38	4.21	12.42	14.90	2.34	1.67	66.03
1892...	0.19	0.00	0.00	0.00	13.30	9.80	9.19	7.48	12.22	21.26	4.40	0.43	78.27
1893...	0.06	0.39	0.00	0.11	20.03	21.14	13.22	18.70	14.00	13.56	1.44	2.48	105.13
1894...	2.12	2.36	0.08	0.00	7.76	6.32	3.64	4.57	4.33	14.62	3.21	0.43	49.44
1895...	0.00	0.08	0.19	0.39	8.11	1.10	5.25	3.42	8.01	8.97	2.04	0.20	50.56
1896...	0.40	0.08	0.00	T.	3.26	6.23	7.43	6.57	7.40	7.42	8.62	0.39	47.80
1897...	0.33	T.	1.04	0.00	21.30	24.34	6.41	12.10	17.63	33.85	5.15	1.28	123.43
1898...	1.07	0.12	0.10	0.00	16.17	18.95	13.65	.....	.....	.....	...	.....	.....
Means.	0.45	0.24	0.30	0.29	8.38	11.20	6.83	7.94	9.54	17.38	4.27	1.19	67.56

RAINFALL IN NICARAGUA.

By A. J. HENRY, Chief of Division.

As supplementary to the record of rainfall by Mr. William Cline at Masaya and Granada, in Nicaragua, published on page 162 of the MONTHLY WEATHER REVIEW for April, 1898, and the table by Dr. Earl Flint at Rivas, Nicaragua, on page 305 of the current number of the REVIEW for July, the following statistics given for other places have been collected from the respective publications, and are reprinted for convenience of reference:

(1) GRANADA.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1876...	.....	.....	.....	.....	5.77	13.65	26.61	4.96	.....	.....	.....	.....	.....
1877...	0.00	0.00	0.00	0.00	11.57	10.24	10.12	5.82	17.36	5.27	0.87	0.59	61.34

(2) GRANADA.

1883...	0.35	0.00	0.00	0.18	0.28	5.20	2.66	5.47	9.74	19.91	3.64	0.00	47.43
1884...	0.00	0.00	0.00	0.00	0.00	8.25	3.99	3.75	8.82	8.63	2.28	0.26	35.98

(3) BLUEFIELDS.

1883...	.....	.....	.....	....	.....	.....	.....	.....	3.42	8.13	12.13	17.00	.....
1884...	10.25	6.39	3.21	2.06	2.67	8.01	17.06	16.40	5.82	4.99	9.71	11.15	97.72
1885...	1.96	1.60	2.66	2.87	5.89	13.37	19.82	11.75	8.07	2.69	7.70	3.15	81.53
1886...	7.28	*3.94	1.63	.....	.....	.....	.. ...	8.55	.....	.....	.....	.....	.....

*For twenty-four days only.

(4) GREYTOWN.

1890...	26.80	6.36	5.93	18.11	4.93	46.84	52.55	35.72	8.14	24.36	25.55	41.65	296.94
1891...	20.30	2.57	1.95	10.40	13.78	26.95	23.57	19.49	14.16	20.21	28.15	32.74	214.27
1892...	28.57	11.38	4.98	18.38	50.88	13.42	38.96	23.63	11.47	27.95	36.93	24.65	291.20
1893...	17.70	7.53	3.93	9.99	2.77	.....	.....	.....	.....	.....	.....	.....	.....

(1) *Granada.*—Observations made in 1876 by Ramon Espinola; in 1877 by Earl Flint; from unpublished manuscripts in Weather Bureau. Location, N. 11° 56′; W. 85° 54′; elevation, 218 feet.

(2) *Granada.*—Observations made at the National Institute. Location, N. 11° 56′; W. 85° 54′; elevation, 230 feet. Reported in Senate Ex. Doc. No. 99, Forty-ninth Congress, first session.

(3) *Bluefields.*—Observations by Hon. W. H. Jackson and others. Published in the International Bulletin of the Signal Service. Location, N. 12° 00′; W. 83° 43′; elevation, — feet.

(4) *Greytown.*—Observations made under the direction of Dr. J. E. Stubbert, of the Nicaragua Canal Company. Location, N. 10° 59′; W. 83° 42′; elevation, — feet. Reported in Senate Ex. Doc. No. 74, Fifty-third Congress, second session, pp. 54–55.

According to the report of the United States Nicaragua surveying party for 1895, by A. G. Menocal, Civil Engineer, U. S. N. (Forty-ninth Congress, first session, Senate Ex. Doc. No. 99, p. 36), Col. O. W. Childs, an American engineer, made the first careful survey for a canal by this route in 1850–51. His meteorological records were taken at Rivas from September 7, 1850 to March 11, 1851, and in the valley of the San Juan River, from the latter date to September 25, 1851.

Commander E. P. Lull, U. S. N., in charge of the United States Survey expedition of 1872–73 (see ——— Congress, —— session ——), obtained a meteorological record from July 1, 1872 to March 14, 1873, at Virgin Bay, 4 miles south of Rivas.

The National Institute of Granada established a well conducted system of meteorological observations in 1880 at Granada (N. 11° 56′, W. 85° 51′; elevation, 229.6 feet). The monthly means for 1883 and 1884 are given by Menocal in his report of 1885, in lieu of any special observations by his own survey party, which left Washington December 17, 1884, beginning operations in Nicaragua on January 22, and leaving that country May 12, 1885. This record as published by him is as follows (the thousandths have been omitted from the rainfall):

RAINFALL.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1883...	0.35	0.00	0.00	0.20	0.28	5.20	2.66	5.47	9.74	19.91	3.64	0.00	47.44
1884...	0.00	0.00	0.00	0.00	0.00	8.25	3.99	3.75	8.82	8.63	2.28	0.26	35.98

NUMBER OF RAINY DAYS.

1884...	0	0	0	0	0	10	12	9	16	17	8	2	74

WIND.

1883...	NE.	E.	E.	E.	E.	E.	SE.	E.	E.	NE.	NE.	N.	E.
1884...	SE.	E.	SE.	NE.	NE.	E.	E.	E.	E.	SW.	SE.	NE.	E.

MAXIMUM TEMPERATURE.

1883...	88.5	88.0	89.0	91.0	93.0	91.0	89.5	89.5	89.5	88.0	88.0	88.0	89.4
1884...	86.0	87.0	89.0	91.5	91.5	91.5	90.5	90.5	89.5	89.5	89.5	87.0	89.4

MINIMUM TEMPERATURE.

1883...	70.0	69.0	71.5	75.0	73.5	78.0	71.5	68.0	71.5	70.0	68.0	66.0	71.0
1884...	70.0	66.0	65.0	71.5	73.5	70.0	71.0	68.0	68.0	68.0	69.0	68.0	69.0

MEAN TEMPERATURE.

1883...	81.0	82.0	82.5	83.0	84.0	82.5	81.5	81.0	80.0	79.0	77.5	75.0	80.8
1884...	80.0	80.0	81.0	82.0	81.0	80.5	81.0	83.5	82.5	79.0	82.0	80.0	81.0

MEAN BAROMETER.

1883...	29.70	.66	.74	.70	.66	.63	.63	.68	.60	.68	.67	.67	29.67
1884...	29.65	.64	.60	.64	.64	.61	.61	.58	.56	.62	.64	.65	29.62

RAINFALL OF MASAYA AND GRANADA, NICARAGUA.[1]

By A. J. HENRY, Chief of Division.

Dr. Earl Flint, for many years voluntary observer of the Smithsonian Institution and the Signal Service, and the present correspondent of the Weather Bureau for Rivas, Nicaragua, furnishes the following table of rainfall, as observed by Mr. Cline.

Masaya is in latitude 12° 2′ N., longitude 86° W.; Granada is in latitude 12° N., longitude 85° 56′ W. Observations were made by Mr. William Cline, civil engineer, at Masaya,

[1] Reprinted from the April Review.